§ 207. VERNATION IN BOTRYCHIA,

With special reference to its importance as a means for distinguishing the different species.

The difficulty in being able at all times to distinguish and separate the different species of Botrychium, on account of the numerous intermediate forms that apparently connect them with one another, has led many excellent botanists to regard all of the smaller species as modifications of one original type, and even to connect them with the larger species through a graduated succession of forms. Thus *B. Virginianum* is reduced through the Var. *gracile* to *B. lanceolatum*, which passes through *B. matricariaefolium* into *B. Lunaria*, which, in its turn, passes into *B. simplex*, the ternate form of which connects by another graduated series with *B. ternatum*. The difference in the time of the fructification of the several species in this arrangement is apparently lost sight of, or regarded as of no consequence. But this theory, in place of relieving, tends rather to increase perplexity, and makes the study of the genus even more difficult, as, after all, it does not lead to any satisfactory conclusion, or uniformity among botanists, and, at best, can only be considered as an easy but very unscientific method of evading difficulties that a more searching investigation would overcome.

All of these difficulties, however, come from relying too much upon merely external characters, and not paying sufficient attention to the internal structure and organs of reproduction. No good species can exist without possessing characters by which it may at all times be identified. Sometimes these characters are conspicuous, while at other times they are so concealed as to require a very careful examination to discover them, but in some form or other they are always present.

That the different species of Botrychium are distinctly characterized I have no doubt whatever. But the many intermediate forms that occur show that external characters at times are not to be depended upon for distinguishing the different species under all of their modifications. Happily each species contains within itself unvarying characters by which we may at all times recognize it, and these characters are to be found either in the buds or spores.

As the character of the spores can only be determined by a very high microscopical power, I shall not describe them in my present paper, but confine myself to a description of the buds, the form of which can be readily seen with an ordinary pocket lens, and in the larger specimens with the naked eye, thus being within the reach of ordinary observation.

Having examined a large number of buds, in living and pressed specimens, of all our North American Botrychiums, I have found that, however much a species varies in its external characters, the form of the bud always remains the same.

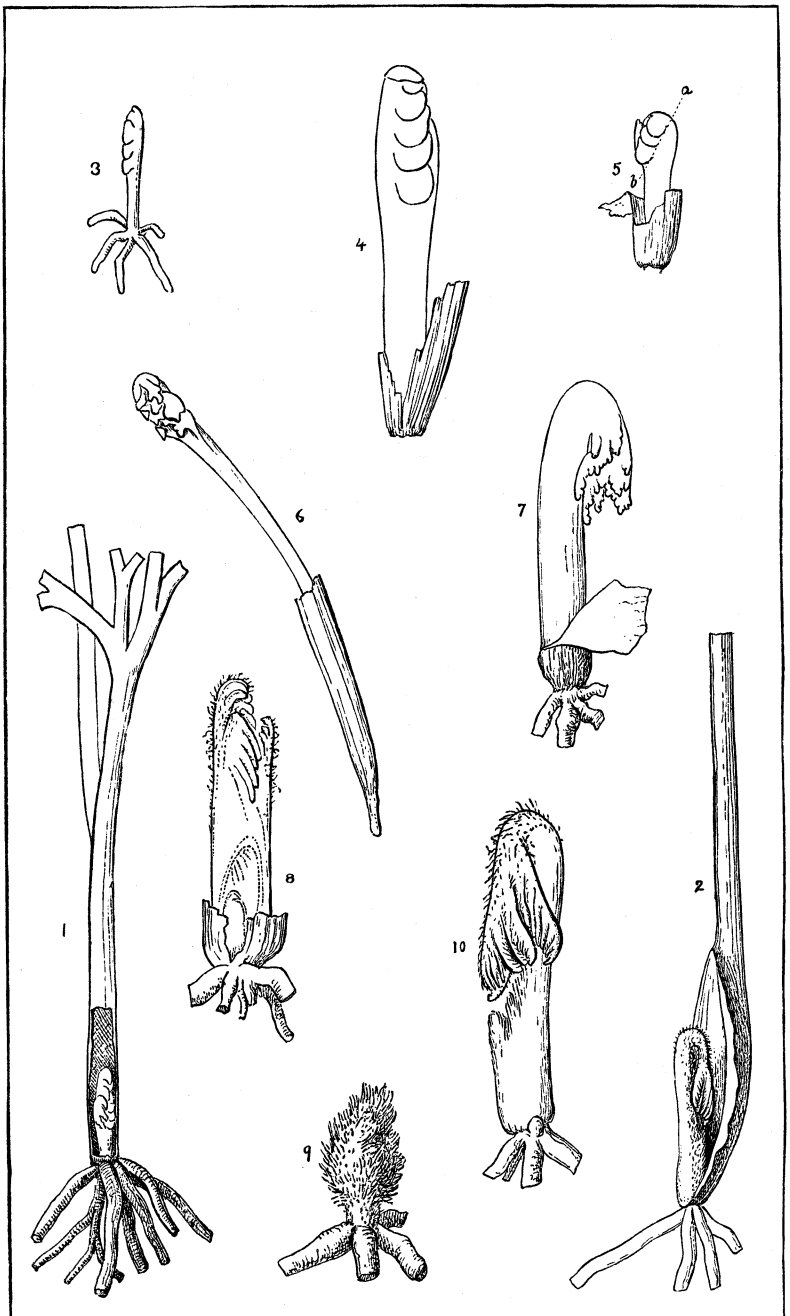
In *B. ternatum* and in *B. Virginianum* the buds are pilose, but differ so much from each other in form that there would be no

difficulty whatever in separating these two species by their buds alone, even if their external characters were similar. In all of the smaller species the buds are perfectly smooth, and this proves conclusively that they cannot be mere modifications of the larger species.

In very young specimens of the smaller species, where the bud has not yet developed into its peculiarly distinctive character, there is an apparent limit in the extent to which we can rely upon these bud-forms, and it may be necessary in some cases, when there is a doubt otherwise in regard to the specimens, to examine the spores, which never vary. Yet, although in the youngest, undeveloped conditions of the plant the bud can hardly be said to have any form beyond a merely simple and erect one, still even in very young buds of corresponding specimens there is usually a significant development of the common stalk that distinguishes them from each other. In *B. matricariae-folium*, for example, the matured form of the bud is so distinct from that of every other species that one could not possibly mistake it for any other, yet, in its earlier stages of development, it at one time bears some resemblance to the matured bud of *B. simplex*, at another time to the matured bud of *B. Lunaria*, and only gradually assumes with its growth its distinctive character. It will be observed, however, that even in its youngest condition it is not only distinguished from the bud of *B. simplex* by the partially curved apex of the sterile portion, but by the significant development of the common stalk, that being by far the longest portion of the whole bud, whereas in *B. simplex* the common stalk is usually the shortest. In all such specimens that I have examined the common stalk in the bud of *B. matricariaefolium* has been more strongly developed than in either of the other species, and in any case, of these three species, in which the greatest difficulties and confusion occur, given specimens of an equal and corresponding growth, the buds will be found to be distinct and characteristic. Milde states, in his description of *B. matricariaefolium*, that the common stalk in the bud of that species is less developed than it is in the bud of *B. Lunaria*, but I have not found this to be the case. After reading over again his description I re-examined all of my buds, with the same result as before. I can only say that, in every examination that I have made, the appearances have been exactly as I have described them throughout these notes. On the other hand it is quite probable that Milde may have referred to the stoutness of the common stalk, as shown in its circumference, when speaking of its development, in which case my own observations would come nearer to his—though I have sometimes found the stalk in *matricariae-folium* to be as stout as that in *B. Lunaria*,—but I have construed the expression "developed" here to indicate the comparative length of the common stalk in the different buds.

The buds of all Botrychiums, with the single exception of *B. Virginianum*, are *imbedded* in the base of the stipe, as shown in figure 1.

In B. VIRGINIANUM, however, the bud is merely enclosed in a smooth upright-cavity at one side of the lower part of the common stalk, as shown in figure 2.



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The special vernation of the different species is as follows :

In B. SIMPLEX both portions of the bud are straight, the fertile frond being enclosed within the folding sides of the sterile. The common stalk is the shortest portion of the whole bud and usually much less developed than in the other small species. The apex of the sterile frond is never curved, or bent over, but is always erect. Figure 3.

The doubts which have so long obscured this species are being gradually removed, and it will soon be universally recognized as a good species. Heretofore the German authors alone appear to have fully understood its true character, and it has long been placed by them on an independent basis. But, through the frequency of later discoveries, it is now becoming more familiar to our own botanists, and the time will come when it will cease to be a stranger to any herbarium. The species has been described at length by Milde in his Monograph on the Botrychiums, and figured by him in all of its forms in Nova Acta. Vol. XXVI. (1858) and more recently in my own paper published by Mr. Robinson, (1877).

In B. LUNARIA the apex of the sterile frond in the bud is always inclined, or bent over the nearly erect fertile frond in a hood-like manner. The common stalk is usually more strongly developed than it is in *B. simplex*, but not so prominently as in *B. matricariaefolium*, and the segments of the sterile frond are arranged very nearly perpendicularly. Figure 4.

This species continues rare within the limits of the Unites States, but the Syracuse specimens described in the TORREY BULLETIN for October, 1877, suggest the probability of its occurring more frequently than is generally supposed, and that some forms of it may have been confused heretofore with other species.

In B. BOREALE the apex only of the sterile frond is bent over inside (in *B. Lunaria* it is bent over on the outside) of the upper segments. The nearly erect fertile frond comes up between the lowest pair of sterile segments with its apex outside of but inclined toward the apex of the sterile frond. The segments of the sterile frond are arranged on an angle that exactly indicates its deltoid form in the living plant. (This may be understood better by referring to Emerton's figure, he having emphasized this point for me by a dotted line *a*, *b*, through the upper portion of the bud.) Figure 5. In consequence of this arrangement, the lower part of that portion of the bud composed of the two fronds bulges out and appears much broader than the common stalk.

I have not been able to obtain sufficient data to justify me in speaking of this species with any degree of confidence. The two specimens from Sweden in the "Davenport Herb." Mass. Hor. Soc., are the only ones that I have seen, and only one of these contained a bud. Reasoning, however, from analogy, it appears safe to assume that the figure given fairly represents the prevailing form of the bud in this species.

Milde does not give any special description or figure of the bud in this species, his only allusion to it being in his introductory chapter on vernation, where he speaks of a similarity in the vernation of

B. Lunaria, *B. boreale* and *B. matricariaefolium* with that of *B. simplex*, and makes the statement that in the three former species the tips of both the sterile and fertile portions are bent downward. This, however, does not agree with my examinations, nor with his own illustrations, as his figure of the bud of *B. Lunaria* clearly shows. In that figure the apex of the fertile frond is not bent down but fully agrees with my description and examinations. This species is credited to Unalaska (Milde) and so is included in our list of North American Botrychiums, but I do not know of any American specimens in this country.

In B. MATRICARIAEFOLIUM the apex of the fertile frond is bent downward in the bud toward the sterile frond, which clasps it with its side divisions and bends its apex downward over the whole. Figure 6. The common stalk shows a greater development than in *B. simplex*, or *B. Lunaria*, and this significant development indicates the relative position of the sterile frond in living specimens of these three species.

I have already remarked on the resemblance of the bud-form in this species during its earlier stages of growth to the matured bud-forms in *B. simplex* and *B. Lunaria*, but the tendency toward its described form may be detected from the beginning. In very robust specimens, both portions of the bud are sometimes too clumsy to conform exactly to the symmetrical arrangement of the typical form, but in all such cases the apex of both fronds turn downward in conformity with the proper arrangement.

In B. LANCEOLATUM both the fertile and sterile portions of the bud are curved and bent downward their whole length. The fertile frond is recurved and lies with its outer surface pressed close to the common stalk. The sterile frond is turned downward its whole length, its segments spreading over, and covering all of the longer fertile frond but the apex, which protrudes slightly beyond. Figure 7.

The bud-form in this species bears some resemblance to the bud in *B. Virginianum*, but its perfect smoothness and longer fertile portion are sufficient marks of distinction even if others did not exist. It is interesting to trace the development of the bud in this species from the beginning when a mere slit in its apex, and only a very slight curvature of the two portions indicates the direction in which it is passing to its true form.

In B. TERNATUM, and its varieties, the bud is very short and shaggy, the upper portion being so thickly covered with a hairy pubescence as to obscure the arrangement of the two fronds completely. This pubescence is wholly confined to the upper portion of the bud, the stalk remaining perfectly smooth. It is remarkable that in the huge California forms, some of which are nearly two feet high, and which, in part at least, belong to Milde's "*Forma Australasiaticum*," differing only in being less serrate, the buds are less shaggy, and the arrangement of the two portions may be seen more readily, but the plants themselves are more pubescent, and retain their pubescence longer than any that I have seen from other localities.

Milde states that in this species the apex of the fertile panicle is not only bent downward in the bud, but that the *tip is again bent*

upward, being in fact sub-circinate, so that in his classification of the different kinds of vernation he places this species in a class by itself which he calls "vernatio sub-circinata." This, if correct, appears to me to be a most important point, as it would show a much closer relationship to the true order of Filices than is usually recognized in this genus, but I have not been able to verify it. The figure of the bud given by Milde does not in any way agree, either with his text, or my own examinations, and is a very unsatisfactory presentation of the bud as it really is; yet I can hardly understand how so thorough and careful an investigator should be mistaken in so important a particular. I can only say that I have found the buds in this species to be precisely as I describe them. I cannot explain the arrangement of the two portions of the bud better than by saying that the fertile frond starts from the main stalk below the base of the sterile frond, folds its primary divisions inwardly, and turning downward its apex—the tip of which in the buds examined by myself I have found to be slightly curved inwardly but not again turned up,—lies close up to the inner surface of the main stalk, and that then the sterile frond bends down its own apex, over which it folds its upper divisions and continues to fold in the succeeding divisions, until the two lower primary segments clasp the top of the fertile frond. If one will close each hand separately, and then place both together so as to form a double fist, with the thumbs bent downward, inside, he will have a very good idea of the manner in which *B. ternatum* folds in the divisions of its two fronds, while the bent thumbs will very nearly represent the curved apex as I have found it, in my examinations. The buds for the second and third years are perfectly smooth. That for the second year shows a development quite similar to the bud in *B. Lunaria* for the first year; that for the third year is too small to be clearly defined by an ordinary pocket lens. (Mr. Emerton's figure, No. 8, shows the position of the buds of two following years in the base of the first year's bud.) I give two figures of the bud in this species, figure 8 showing the arrangement of the fertile and sterile fronds, and figure 9 representing the natural appearance of the bud with its shaggy covering. Being still anxious to verify Milde's statement in regard to the apex of the fertile panicle in this species, I wrote to Mr. Robinson, requesting him to make some independent examinations with this object in view. The result has only confirmed my own observations. Still, unwilling to believe that Milde is in error, I would rather attribute our apparent disagreement to a want of properly understanding him on my part, and believe that the difference may yet in some way be satisfactorily explained. Mr. Robinson has also made some very interesting camera observations on longitudinal sections of that portion of the stipe containing the buds, from freshly gathered living plants of *ternatum-obliquum*, in which he traces the buds for 1878–79–80, and possibly 81, showing how well this genus provides for the growth of succeeding years.

In B. VIRGINIANUM the whole of the bud, including the common stalk, is more or less clothed with a hairy pubescence, but not sufficiently so to obscure the arrangement of the two portions, which

are curved and turned downward their whole length in precisely the same manner as in *B. lanceolatum*. In this species, however, beside its pubescence, the bud is further distinguished by the longer sterile frond, the apex of which extends beyond and hides the fertile panicle. Figure 10.

I sum up the result of these notes in the following classification of the different kinds of vernation based on my own investigations, and append that of Milde for comparison. As the points of difference between us are independent of the general character and form of the buds themselves, the purpose for which I have brought forward these bud-forms is not affected by an apparent disagreement on other points, which further investigation on my part may wholly remove.

1. VERNATION WHOLLY STRAIGHT:
   1. *B. simplex*, Hitch. Bud smooth. Apex of fertile and sterile frond erect. Figure 3.
2. VERNATION PARTLY INCLINED, in one or both portions.
   1. *B. Lunaria*, Swz. Bud smooth. Apex only of sterile frond bent over and outside of the nearly straight fertile frond. Segments of sterile frond arranged nearly perpendicularly. Figure 4.
   2. *B. boreale*, Milde. Bud smooth. Apex of sterile frond bent over inside of the nearly erect fertile frond. Sterile segments arranged on an angle. Figure 5.
   3. *B. matricariaefolium*, A. Br. Bud smooth. Apex of both fronds turned down. Sterile frond clasping the fertile, with its apex overlapping the whole. Figure 6.
   4. *B. ternatum*, Swz. Bud pilose. Apex of both fronds bent down with a slight curve inward. Figures 8 and 9.
3. VERNATION WHOLLY INCLINED, in the fertile frond recurved.
   1. *B. lanceolatum*, Angstrôm. Bud smooth. Fertile frond recurved its whole length, the shorter sterile frond reclined upon it. Figure 7.
   2. *B. Virginianum*, Swz. Bud pilose. Fertile frond recurved its whole length with the longer sterile frond reclined upon it. Figure 10.

Milde's classification is as follows:

"*Vernatio stricta.*" (B. simplex.)
"*Vernatio inclinata.*" (B. Lunaria, matricariaefolium and boreale.)
"*Vernatio reclinata.*" (B. lanceolatum and Virginianum.)
"*Vernatio sub-circinata.*" (Fertile panicle of B. ternatum.)

The importance of the bud-forms in Botrychia as a means for determining specimens, or as a help to a better knowledge of the genus cannot be overestimated. In the very youngest plants of the smaller species it will be safer, perhaps, to rely upon the unvarying character of the spores, when there are doubts in regard to their identity; but from the time when the buds begin to take upon themselves any form they will be found to be the best available means for determining specimens in all cases where the external characters are too uncertain to be relied upon. By their aid alone I have been able to place satisfactorily specimens that have long remained

in a doubtful position. Among others, two specimens of *B. matricariaefolium*, which, on account of the unusually high position of the sterile frond, and their very acute segments, I had removed from my sheet and placed with *B. lanceolatum*, I have since been able to return to their proper place.

I have found on examining a great many specimens that in that wonderful species (*B. matricariaefolium*) the segments are often more acute than they are usually credited with being, and that the sterile frond is sometimes approximate to the fruit panicle as in *B. lanceolatum*, while in the latter species the sterile frond is at times placed far down upon the common stalk, so that it is extremely difficult, if not impossible, at times to distinguish them by their external characters alone: but their bud forms are invariably distinct.

Taking full grown specimens of *B. simplex* and *B. Lunaria* the general appearance of the sterile frond in each will sometimes be found to resemble the other so much, in the form of the segments, that it is difficult to understand why the apex should be bent over in one species and not in the other. Such, however, is the fact, and while it illustrates nature's methods in preserving her marks of distinction between species otherwise similarly related, aud furnishes us with reliable characters by which to distinguish them under different conditions, it also proves very clearly, to my mind, the distinctive character of the different species of Botrychia.

BOSTON, Nov., 1877. GEO. E. DAVENPORT.

NOTE.—The figures with which these notes are illustrated have been drawn by Mr. J. H. Emerton, directly from the buds furnished to him for that purpose by myself. Nos. 1 and 2 are of natural size; the proportions of the others have been enlarged to give more distinctness to the parts. G. E. D.

§ 208. **Camptosorus rhizophyllus,** Link.—It is with pleasure that I inform you of the discovery of Camptosorus rhizophyllus in this vicinity, and within 14 miles of Boston. It was found growing on a rocky knoll near the banks of the Charles River, and, as it has never before been reported this side of Mt. Tom, in the western part of the State, its presence here will be received with rejoicing by the many lovers of ferns in this quarter. WM. EDWARDS.

SOUTH NATICK, Dec. 17th, 1877.

§ 209. **Pringle's Plants.**—We recently, § 193, called attention to Mr. Chas. G. Pringle's sets of Alpine, Sub-alpine, and Northern plants of New England, which he offers for sale at ten cents a specimen, or, we believe, for exchange. We have, however, lately received such an endorsement of them from good judges, that we deem it for the interest of our readers to repeat the notice. One correspondent writes: "I received on Saturday a set, and never before knew what good specimens from that region looked like. The color is kept, the specimens are collected root and all, are furnished with very handsome labels, are liberally supplied, the exact date of collection both of flowers and fruit is given, and locality, and all species so requiring have both states represented." Address Mr. C. G. Pringle, Charlotte, Vt.